Particles and HVAC systems

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Outline

- Types of HVAC system
- Overview of central ducted sytem
- Where particles are likely to be collected and efficiency of collection
- Sampling issues
- Conclusion

Type of HVAC systems

- Four basic types of commercial systems
  - All air
  - Air and Water
  - All Water
  - Unitary

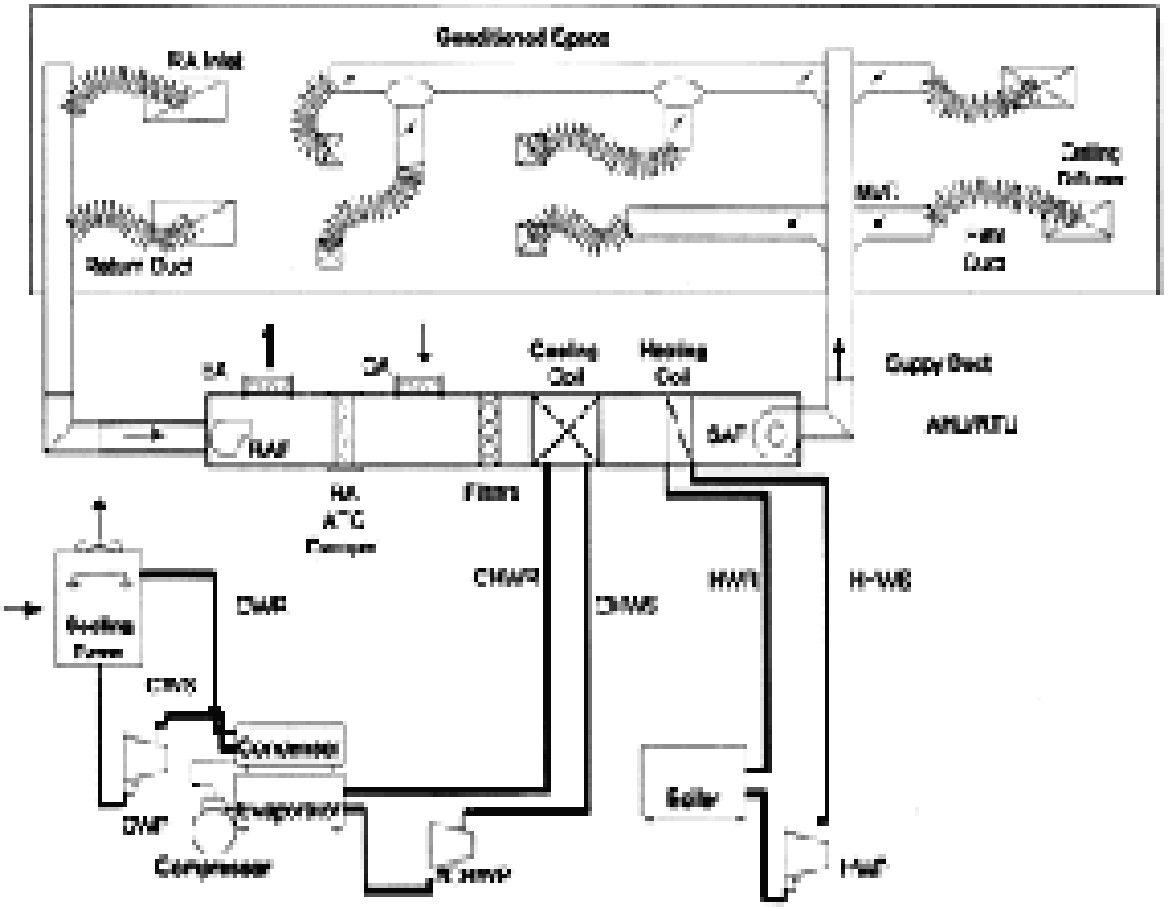
All water

- Circulate chilled water through heat exchanger in terminal or fan coil unit in conditioned space
- No duct work
- Provides heating and cooling but not ventilation (outdoor air)
- Common in hotels

All air and air-water

- Cooling and heating by passing air over exchanger (all air use refrigerant coil air water use chilled and heated water)
- Ducted system
- Used to provide central heating, cooling, and ventilation (outdoor air)
- This is system of interest for rest of presentation

HVAC system (air-water)



Locations for particle collection

- Ventilation filter
- Cooling and heating heat exchangers
- Duct work
  - Most likely in bends
  - Under normal conditions relatively low

Filter rating system

- ASHRE has developed standards for filters
- Previous standard rated by dust arrestance and dust spot efficiency
- Arrestance is basically measure of how much dirt filter can hold
- Dust spot efficiency rough indication of collection efficiency for natural aerosol
- Neither measure directly relates to efficiency

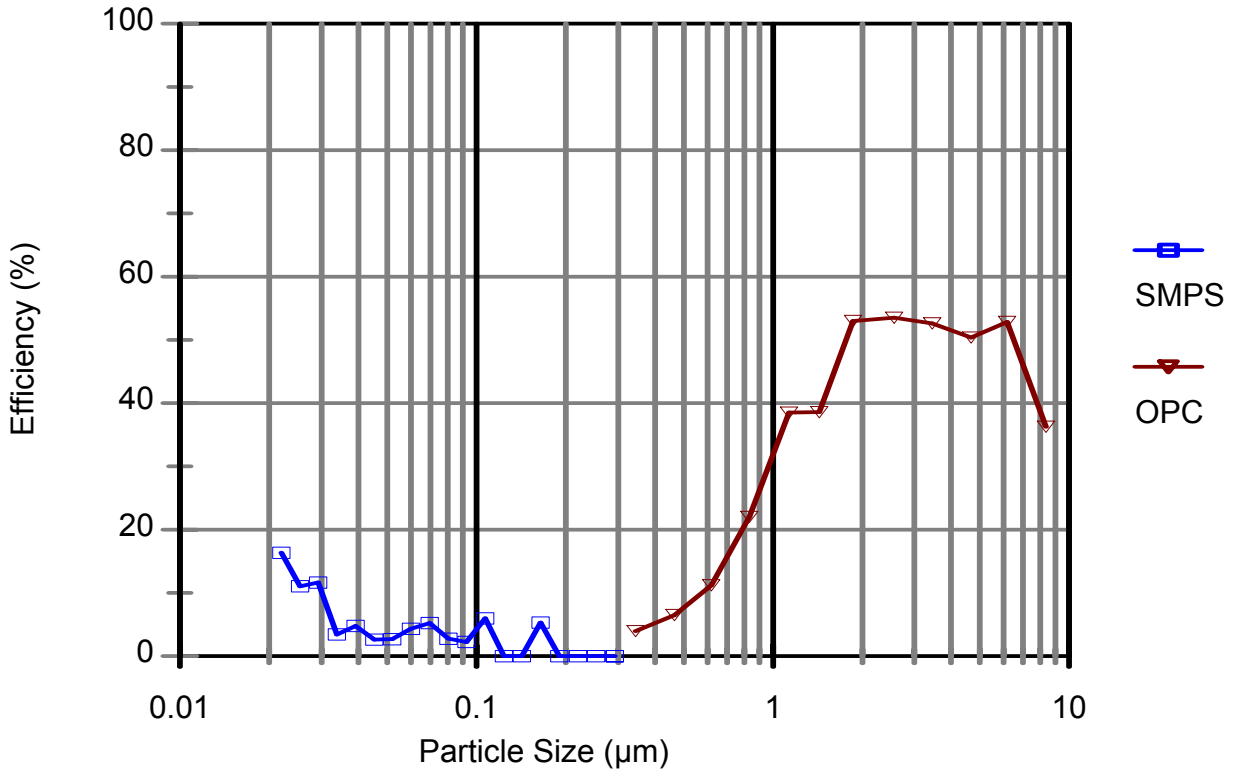
MERV rating

- New standard to overcome limitations
- Directly related of efficiency as a function of particle diameter from 0.3 to 10 microns
- Minimum Efficiency Report Value (MERV) ranges from 1 to 16
- 1 to 4 represents residential furnace filters
- 5 to 8 represents typical commercial filters
- >9 high class filters for special applications

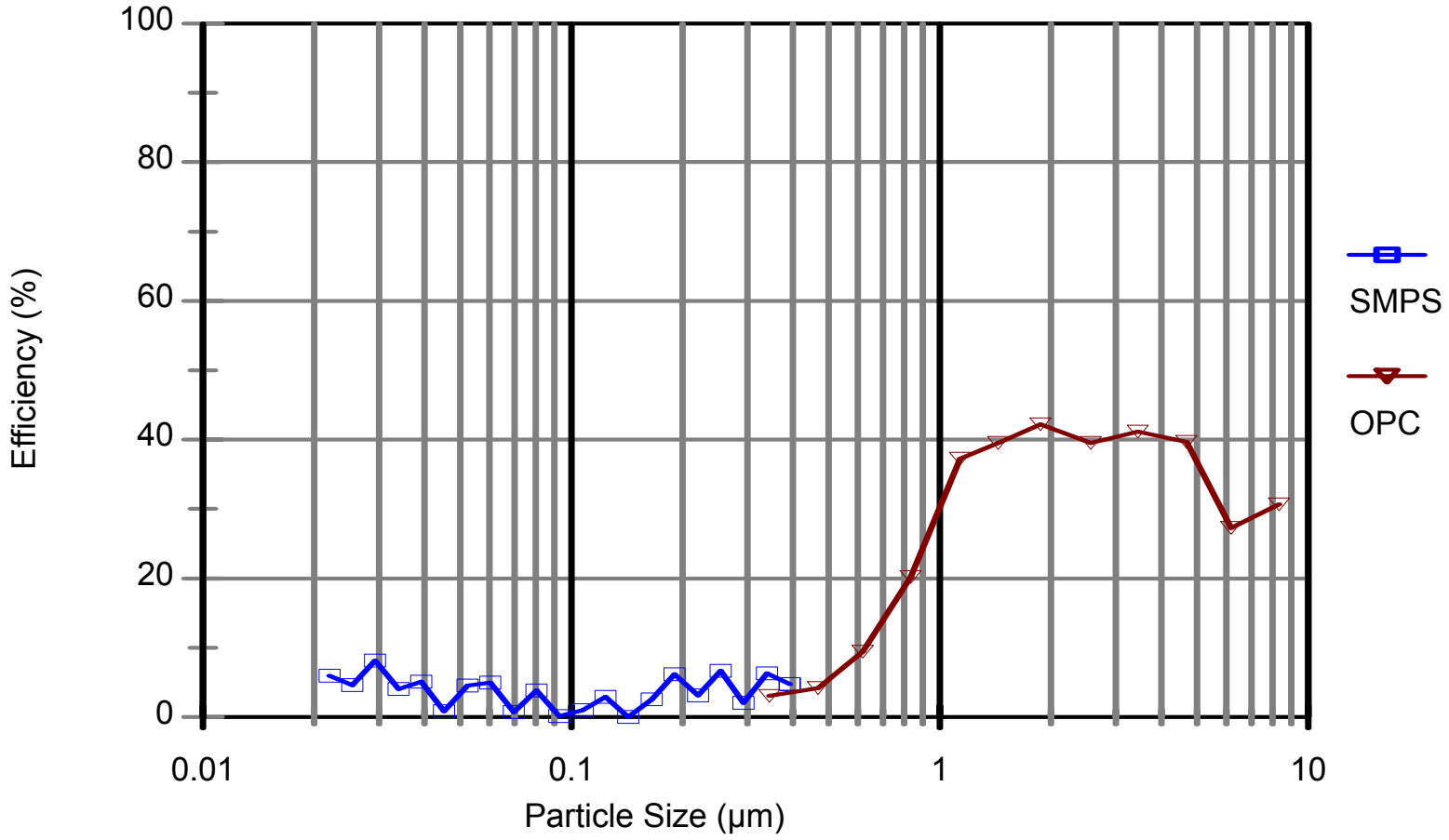
RESEARCH & DEVELOPMENT

Building a scientific foundation for sound environmental decisions

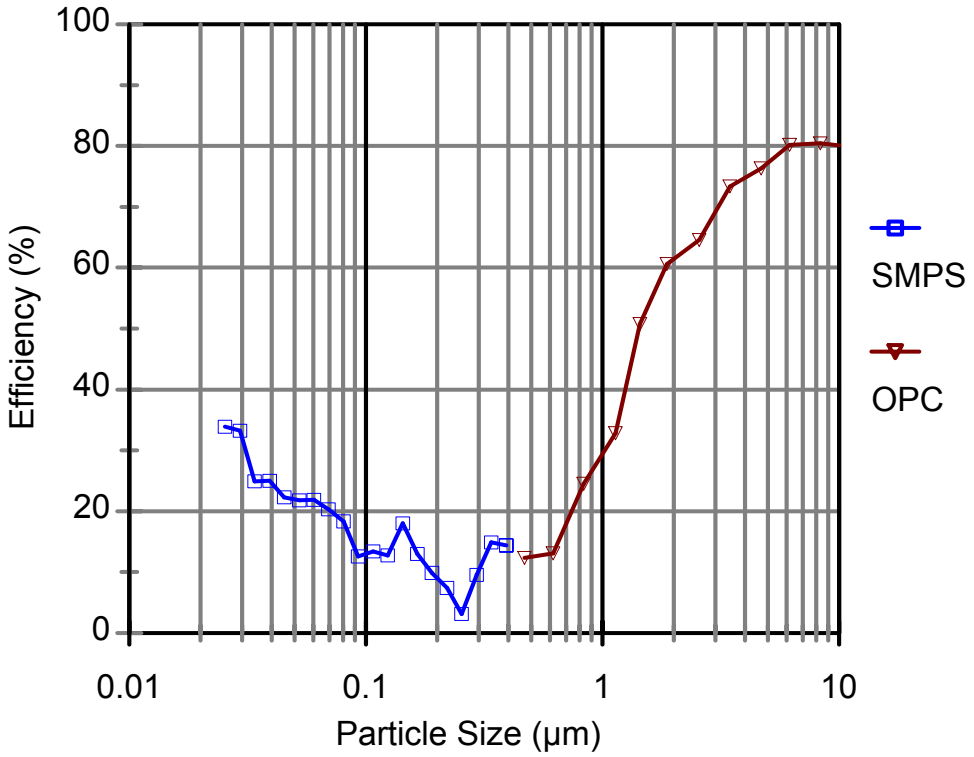
Performance of typical HVAC filter MERV 5



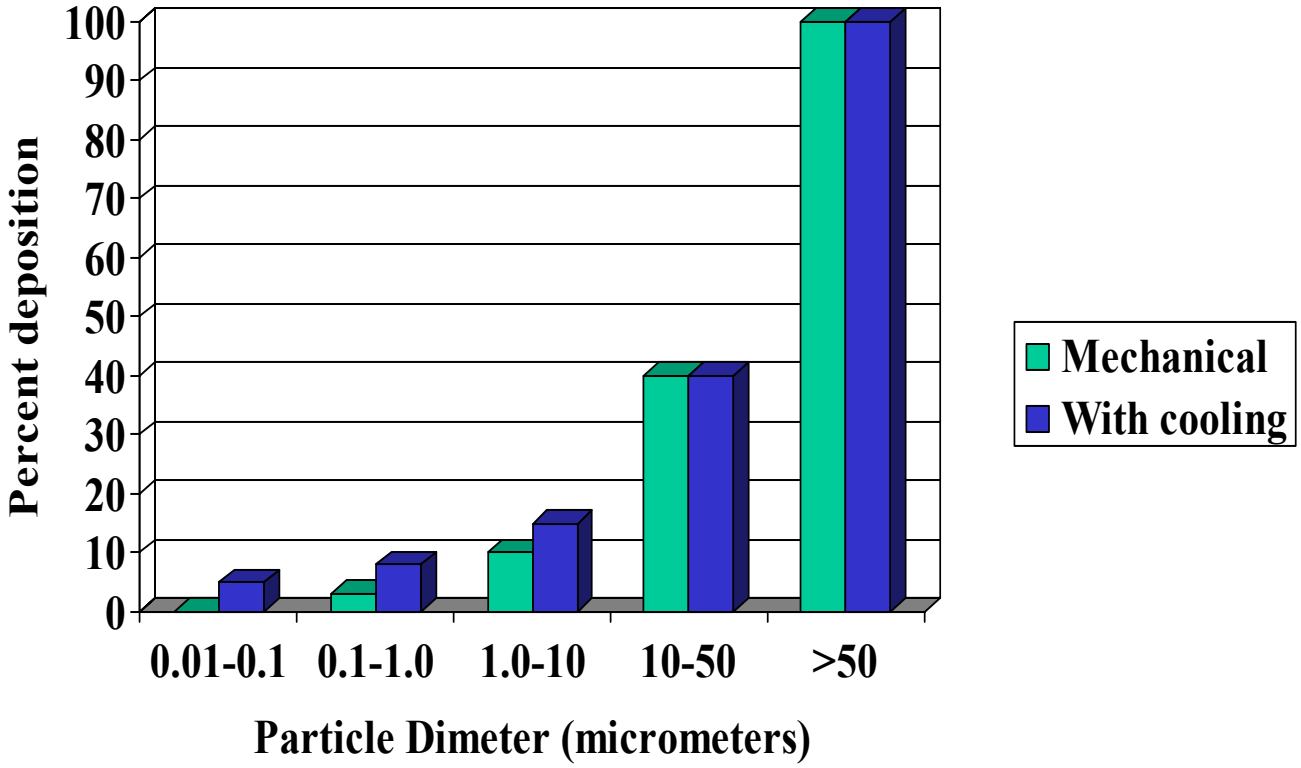
Typical HVAC filter (MERV 6)



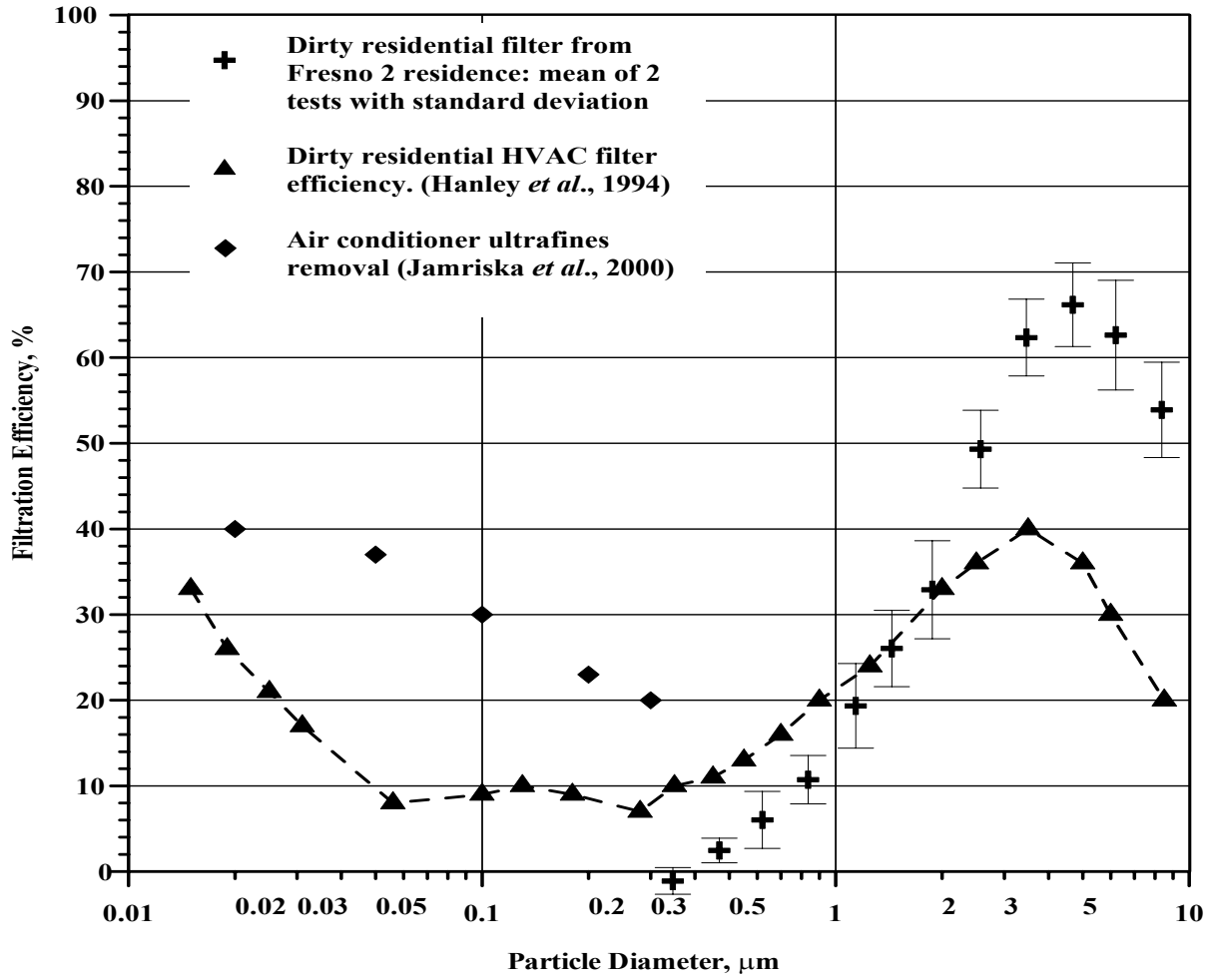
Moderate efficiency HVAC filter (MERV 8)



Deposition on Heat Exchanger Surfaces



Effect of dust loading and AC



Deposition in duct work

- Under normal conditions no significant deposition for long periods of time
- Duct velocities are too high and particle diameters to small for significant deposition
- Deposition occurs at bends in high velocity areas
- Deposition occurs in areas of low velocity

Sampling issues

- Representative sample
- Significant quantities of sample
- Recover information about dust
  - Particle size distribution
  - Composition
  - Morphology

General issues

- Collect sample from material deposited on surfaces
- Poor recovery from surfaces
- May have low concentrations (g/square meter)
- Not representative of size distribution
- May be contaminated

Where to sample

- Filters
  - Biased sample because most particles small than 1 micrometer in diameter not collected
  - Extraction of particles from filter media difficult
  - Sample may be contaminated with material from media

Where to sample (cont)

- Heat exchanger surface
  - Biased sample because most particles will be large (>10 microns in diameter)
  - Sample by washing or wiping
  - Contamination probable
  - Unlikely to be able to recover size distribution information

Where to sample (Cont)

- Duct work
  - Biased sample most particles >5 microns diameter
  - Low concentrations expected
  - Contamination from duct
  - Sampling using wipes or vacuum cleaner
  - Unlikely to recover size distribution information
  - Access to contaminated portion of duct may be difficult

Conclusions

- HVAC filters probably no better than MERV 8 and more likely MERV 5 or 6
- If filters could be located they would provide good sample for analysis with caveat that size distribution is unrepresentative
- Samples can be collected from duct work but they will be biased because of size distribution effects